

**StoSS** landscape urbanism

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**silresim superfund redevelopment study . tanner street initiative**  
**lowell . massachusetts**

*appendices + sources*

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#### **4.1.1 Overview**

In general, improvements to Tanner Street have not been forthcoming by existing property and business owners in recent years simply because there is no financial incentive for private owners to reinvest beyond those functional expenditures required to maintain and improve the operations of their businesses. The state of disrepair with neighboring lands, the risk of contamination, and more significantly the stigma of contaminated lands in the neighborhood have all served as disincentives for existing owners to embark on any noticeable improvements to their lands and buildings. As a result, property values in the region are depressed and as a consequence land and buildings are left abandoned to tax arrears.

Given the general conditions on Tanner Street, over which no individual land or building owner has any direct control, expenditures made to improve the appearance of land and buildings will not provide a financial payback to the owner. Expressed in financial terms, both land and buildings in the area are perceived as a depreciating asset, to be used for a period of time to facilitate the sale or production of their wares and then to be discarded with no residual value. There is no residual value to the owner because there is not market value. There is no market value because new businesses are reticent to relocate in the region because of worsening aesthetic conditions and the risk and stigma of contaminated lands in the region.

This perception of the value of land and building by existing owners is in stark contrast to typical property owners, where land is generally considered as an appreciating asset and buildings, when maintained properly, will have a residual value often greater than what was paid by the owner years earlier. When left without intervention, conditions in the region continue to spiral in a downward direction.

Yet, in spite of apparent and sub-surface conditions, the Tanner Street Initiative represents a unique opportunity for neighboring residents and businesses and the community to realize benefits. Those benefits include

- increased fiscal benefits to community
- increased property values to neighboring residences and business owners
- improved amenities for neighboring residences
- increased revenues to local retailers
- improved employment prospects
- enhanced appearance of entrance to community and neighborhood

Needed to reverse recent trends are multiple, coordinated efforts by both the City administration and private business owners, potential investors, and neighbors. Public-private partnerships are the best way to ensure investor confidence, on the one hand, and to make individual business owners responsible for a portion of the larger district, on the other. Thus, this portion of the document is intended to outline some of the general economic goals; land use, transportation, and environmental issues; and implementation initiatives realizable along the Tanner Street Corridor. In conjunction with this effort, a more detailed market overview has been prepared by Versar, Inc., and is available from the Division of Planning and Development at the City of Lowell.

### **4.1.2 Long-Term Redevelopment Goals**

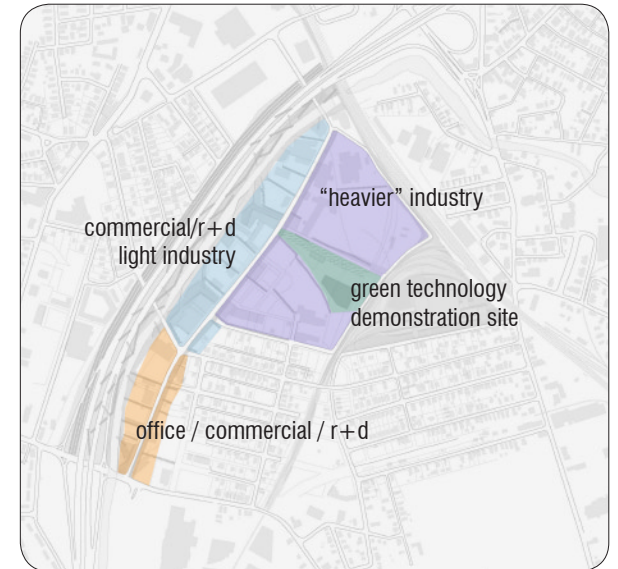
- Minimize adverse impact to neighboring residential and commercial districts
- Optimize visual and ecological resources to establish new image / identity for the district
- Create an environment that stimulates reinvestment by existing businesses and property owners and new investment of clean, leading-edge industries
- Optimize use of existing infrastructure
- Optimize short-term economic opportunities while implementing a long-term vision
- Enhance long-term financial prospects of community
- Recognize competition for limited resources
- Recognize that ongoing re-training and occupational upgrading is a requirement of tomorrow's competitive community workforce
- Strive to maintain financial self-sufficiency for district redevelopment and revitalization plans

### **4.1.3 Land Use Issues**

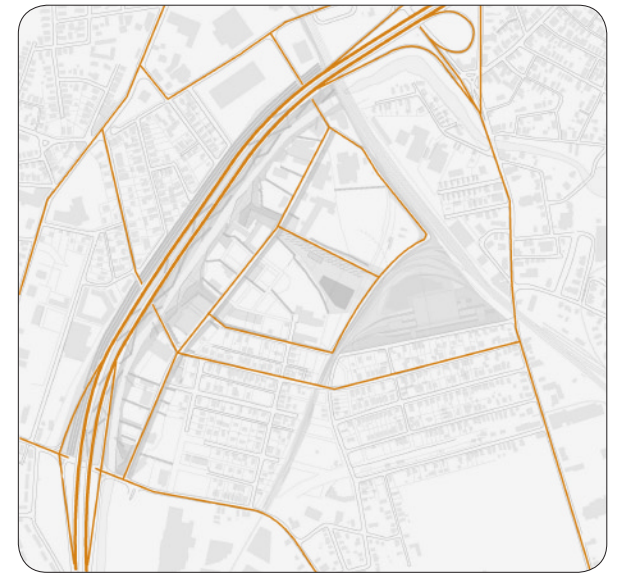
- Heavier industrial uses should be reserved in the region of existing compatible use (north and east of the Silresim site)
- Existing residential areas should be buffered through introduction of light industrial and office/commercial land uses
- Existing commercial areas should be buffered from lighter and heavier industrial uses through introduction of office and ancillary commercial land uses, creating increased market forces
- Amenities should be designed to enhance neighboring residential activities while serving as open space and buffer to industrial uses
- Provide for an occupational re-training and upgrading facility at a high visibility location convenient to commercial district and transportation

### **4.1.4 Environmental Issues**

- Recognize existing environmental constraints and timing of remediation activities, with reference to current and future phased redevelopment opportunities
- Maximize opportunities to enhance existing natural/environmental resources in district for residential, commercial, and industrial users
- Minimize adverse impacts of redevelopment on existing and proposed non-industrial land uses



potential long-term land uses



industrial traffic system



### **4.1.5 Transportation / Access Issues**

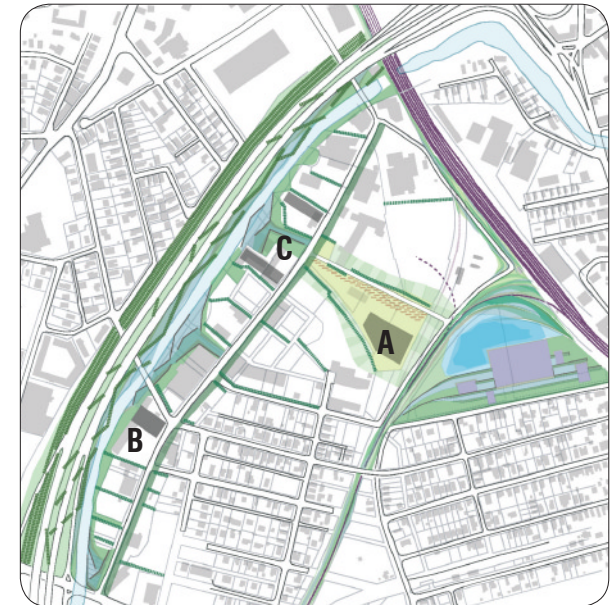
- Concentrate heavier industrial land uses and provide direct access to these properties in order to minimize impact on neighboring residential and commercial land uses
- Minimize the cost of new transportation infrastructure by first redeveloping lighter industrial properties that require minimal infrastructure upgrades
- Increase access to interior parcels (north and east of the Silresim property) in order to optimize potential redevelopment benefits and opportunities to existing land owners
- In extending new roadways, maximize development area, flexibility and street frontage
- Reduce or eliminate westernmost rail spur in order to optimize redevelopment opportunities within the heavier industrial area

### **4.1.6 Short-Term Initiatives**

- On the Silresim property (A), develop a green technology demonstration site as a model for other clean industry initiatives that could follow
- At Lincoln Street (B), arrange property swap or buyout and establish labor re-training center in old Brady Business Forms building
- At Cambridge Street (C), create industrial business expansion / redevelopment opportunities on tax-delinquent sites adjacent to bioremediation terrace pilot installation

### **4.1.7 Implementation Frameworks**

- Establish the Division of Planning & Development (DPD) as oversight agency with full-time TSI coordinator
- Create framework for negotiating land deals/swaps/relocations and fostering expansion of existing businesses
- Generate list of tools and resources for DPD to implement short- and long-term initiatives (see especially section 4.4)
- Provide for workforce re-training facility at designated location
- Focus early economic redevelopment efforts at designated locations
- Create community coordinating committee to represent Tanner Street issues, oversee implementation of short-term initiatives
- Establish forum for community coordinating committee to touch base with city, proposed art committee, neighborhood groups, local high school, clean-energy organizations, and other active stakeholder groups



### **4.2.1 Site Description**

The Site is located at 86 Tanner Street in an industrial area of Lowell, Massachusetts, approximately one mile south of the central business district. The original facility (Silresim Chemical Corporation) consisted of approximately 4.5 acres (Silresim Property); however, the National Priorities List (NPL) site is geographically defined by the extent of contamination which includes approximately 16 acres containing ground water contamination and seven acres of soil contamination (EPA, 1991). The 4.5-acre former Silresim Property is bordered by the Lowell Iron and Steel Company to the north, the B&M railroad yard and tracks to the east/northeast, an automobile salvage yard to the south, and Tanner Street to the west. Residential areas are located south, east, and northeast of the Silresim Property, with the closest residences located on Canada, Main, and Maple Streets, roughly 300 to 500 feet from the Silresim Property boundary. River Meadow Brook lies approximately 400 feet west of the Silresim Property boundary.

The Silresim Site is underlain by a relatively broad layer of glacial outwash deposits over bedrock that range from 20-100 feet thick with an average thickness of approximately 80 feet. The deposits are fine grained and consist primarily of silty sands and silts of lacustrine origin. Underlying the glacial outwash deposits are thin discontinuous layers of glacial till, typically found along the top of the bedrock surface. A bedrock valley lies beneath the Site. While outwash deposits exceed 80 feet immediately beneath portions of the Silresim Property, deposits thin out as bedrock rises rapidly to the north of the property.

Based on the results of the RI (GZA, 1990) and Supplemental RI (CDM, 1991), regional ground water flow in the study area was determined to be generally toward the north and northwest, with depths to ground water at the Silresim Site approximately 6-10 feet below ground surface. Hydraulic conductivities for the outwash deposits were estimated to range between 0.1 and 0.3 feet per day. Up to 40% of the ground water flow from the Site was estimated to infiltrate into the 84-inch municipal brick interceptor sewer which runs in a general east to west direction immediately north of the Lowell Iron and Steel building.

### **4.2.2 Site Contamination**

#### **4.2.2.1 Ground water**

The ROD identified volatile organic compounds (VOCs) as the predominant chemical contaminants that are present in ground water at the Silresim Site. A relatively high concentration ground water VOC plume was identified in the outwash deposits in the study area extending from the south of the Silresim Property, north across the Lowell Iron and Steel property. Over 70 VOC contaminants were identified in the plume, including chlorinated aliphatics, volatile aromatics, and ketones. Representative contaminants and concentrations from the ROD include 1,2-dichloroethene, methylene chloride, 1,1,1-trichloroethane, and trichloroethene all reported at concentrations between 1,000 and 2,000 mg/L (ppm). Overall, the highest VOC concentrations were observed on and to the immediate north of the Silresim Property. VOCs were also detected throughout the outwash deposits, down to bedrock and depths of up to 120 feet.

In addition to VOCs, some semivolatile organics (SVOCs) were reported in ground water, generally at concentrations significantly less than those observed for the VOCs. SVOCs which were reported included isophorone, 1,2-dichlorobenzene, benzoic acid, and phenol. SVOC concentrations typically ranged from 0.1 to 40 mg/L and tended to be more localized than VOCs.

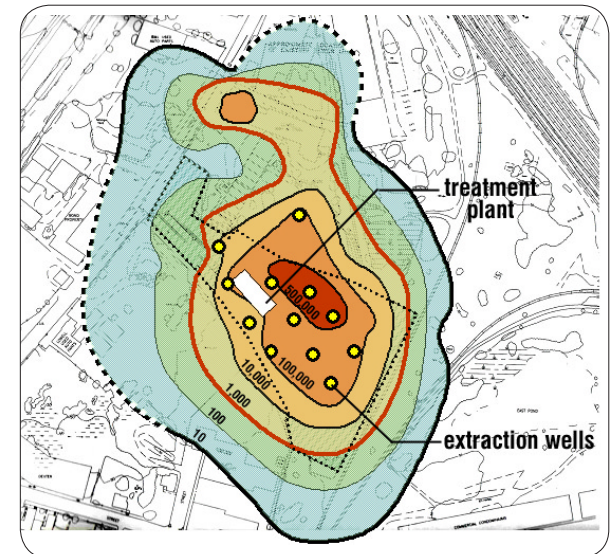


fig. 1 total volatile organic compounds in shallow ground water (ppb)

Metals were sporadically detected in ground water at various monitoring locations. Among those that have been reported are chromium, nickel and zinc. Maximum concentrations for these metals were generally reported between 1 and 2 mg/l. In addition, high concentrations of iron (up to 268 mg/L) were observed at many ground water monitoring locations.

Figure 1 presents the overall VOC plume contaminant concentration contours (for moderate depths) based on the November 1997 annual sampling round. The contours indicate that a highly contaminated ground water plume, whose total core VOC concentrations exceed 1,000,000  $\mu\text{g/L}$ , still remains following over three years of extraction and GWTP operation. The bulk of the ground water plume is located in an elliptical shape stretching from the southern end of the Silresim Property along a northwesterly transect to the northern end of the Lowell Iron and Steel property.

A comparison of the November 1997 data with the Baseline monitoring data and the earlier 1990 Remedial Investigation suggests that there is an ongoing generally northward migration of the ground water plume. This migration is consistent with the direction of ground water flow in the outwash deposits and may also be influenced by the operation of the extraction well array. Portions of the core of the plume have migrated to the north of the (old) extraction well array on the Lowell Iron and Steel property, and appear to be moving in the direction of the City of Lowell municipal sewer lines.

#### **4.2.2.2 Soil**

The ROD identified a variety of VOC, SVOC, and metal contaminants in surficial soils at the Silresim Site that varied depending upon site location. VOCs were relatively widespread including portions of the Silresim Property, the former Arrow Carrier property (to the south of the Silresim Property), and localized areas of the Lowell Iron and Steel property. SVOCs including PAHs, phthalates, PCBs, chlorinated benzenes and dioxins were elevated at the southern end of the Silresim Property and portions of the Lowell Iron and Steel property. Some elevated metals concentrations were observed, primarily in the southeastern portion of the Silresim Property. In unsaturated subsurface soils down to approximately 6-10 feet deep, VOCs were the primary contaminants that were observed. Total VOC concentrations in unsaturated soils across the Site were generally found to range from 100 to 1,000 mg/kg. In addition to VOCs, a number of SVOCs including phthalates, PAHs, and chlorinated benzenes were reported in localized areas with maximum concentrations in the 10-500 mg/kg range. Metals including arsenic, chromium, copper and mercury were also sporadically detected at elevated concentrations.

In conjunction with the implementation of the Source Control remedies at the Silresim Site, a Predesign Soil Investigation was undertaken during 1995 on the Lowell Iron and Steel properties. The purpose of this investigation was to better characterize the nature and extent of surficial and subsurface (primarily unsaturated zone) soil contamination, and to refine estimates of the volume of contaminated soils requiring remediation. This investigation was important due to uncertainties created by soil regrading activities that had occurred on the property in 1990, following the initial remedial investigations. A total of 21 borings that were located in a loose grid array across the Lowell Iron and Steel property. Borings were advanced to depths ranging from 8 to 14 feet. Approximately 72 composite samples of both surficial and subsurface soil were collected.

Analytical results indicated the presence of both chlorinated and aromatic VOCs in the soils, with VOC concentrations ranging from trace levels to levels in excess of 12,000 mg/kg in one subsurface sample. In general, only low levels

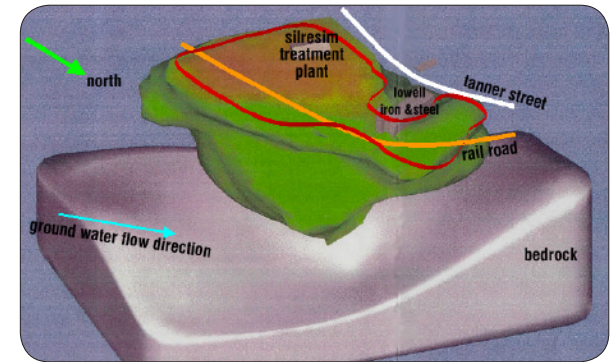


fig. 2 3d model of total volatile organic compounds in ground water @ 1,000 ppb



fig.3 lowell iron and steel property on the north of the silresim site



of total VOCs (<1 mg/kg) were reported for surface soils (0-0.5 feet deep) on the Lowell Iron and Steel property and generally did not exceed ROD cleanup levels. Chlorinated volatiles were the primary VOC constituents in surface soils.

In subsurface soils, VOCs were widely distributed across the Lowell Iron and Steel Property, and frequently exceeded unsaturated zone ROD cleanup levels. High VOC concentrations were observed in both unsaturated (2-4 feet deep) and saturated (6-14 feet bgs) zone soils. The overall results indicate that a large portion of the unsaturated zone (approximately 2-4 feet deep on the Lowell Iron and Steel property exceeds ROD soil cleanup standards (typically 1-10 ppb for individual VOCs), by up to four orders of magnitude in some locations. Chlorinated volatiles were more frequently observed than aromatic VOCs, although a few areas of very high aromatic contamination were observed. Some of the highest soil VOC concentrations were observed in saturated zone soils (including boring SB-26; 8-10 feet) below the water table. The total mass of soil VOCs below the water table may exceed the mass currently above the water table.

Soil volume calculations based on the reported data, indicated that an estimated 37,000 cubic yards of subsurface soil may require VOC cleanup based on comparison to ROD cleanup levels. The estimated areal extent of contamination was similar to the area specified in the ROD. However, considerable uncertainty remains regarding the exact outer limits of contamination (and therefore exact soil volumes).

Analytical results indicated that several semivolatiles (primarily PAHs) and metals were detected in both surficial and subsurface soil samples at concentrations ranging from trace levels to approximately 56 mg/kg. At several locations, PAH concentrations exceeded ROD cleanup levels, primarily in surface soils. Only one soil sample contained non-PAH semivolatile compounds in excess of ROD cleanup levels. Analytical results indicated widespread detection of lead and arsenic. Lead concentrations ranged up to 1,620 mg/kg in one surficial soil sample, with only two samples exceeding the ROD surficial soil cleanup level. Arsenic concentrations ranged from trace levels to 185 mg/kg in one surficial soil sample with a number of samples exceeding the ROD surficial soil cleanup level of 21 mg/kg. Only one PCB sample exceeded the ROD cleanup level of 2.3 mg/kg for unsaturated zone soils. Neither of the two dioxin samples which were analyzed exceeded the ROD surficial soil cleanup level for dioxin.

Overall, based on the study results, it is estimated that approximately 2,200 cy of soil exceed the ROD cleanup levels for non-VOC contaminated soils on the Lowell Iron and Steel property. It should be noted that due to the limited amount of non-VOC sampling which was performed, this estimate may be somewhat high, since a relatively conservative approach was adopted in calculating soil volumes.

#### **4.2.2.3 Surface Water and Sediments**

The ROD identified that limited surface water and sediment sampling was performed in River Meadow Brook and East Pond. Results in River Meadow Brook did not indicate consistent evidence of contamination from the Site although low levels of VOCs were detected in the surface water. Some sediments samples indicated the presence of a few SVOCs including dichlorobenzene and phenol. Other contaminants including PCBs were detected in a few samples. However, it was unclear whether or not the Silresim Site was the source. East Pond surface water samples also showed low levels of VOCs. Sediment samples contained some PAHs possibly of site origin.



fig.4 east pond on the west of the silresim site

#### **4.2.2.4 Air**

Air sampling programs were conducted to evaluate emissions from air vents in the clay cap covering the Silresim Property. Elevated VOC emissions were detected from certain vents in the cap area. The primary VOCs detected included trichloroethene and 1,1,1-trichloroethane with maximum detected concentrations of these compounds of 564 ppm in air and 377 ppm. An indoor air sampling program was also conducted in Lowell Iron and Steel's facilities, primarily in building basement areas. A number of VOCs were detected in basement air at the Lowell Iron and Steel facilities, including both chlorinated (1,1,1-trichloroethane, trichloroethene, tetrachloroethene, etc.) and aromatic (benzene, toluene, ethyl benzene etc.) species. Methylene chloride was reported at 71 ppm. Based on available information, it was suggested although not confirmed that these airborne VOCs might be related to vapors from the nearby municipal interceptor sewer system rather than the Silresim Site.

### **4.2.3 Remedial Actions**

#### **4.2.3.1 Remedial Actions Conducted Prior to Record of Decision**

Cleanup activities at the site began in 1978, when the Massachusetts Division of Water Pollution Control installed a chain link fence around the Site and removed approximately 30,000 drums and tanks containing waste. Approximately one million gallons of hazardous waste were removed during this remedial action. In 1983 and 1984, the EPA demolished the existing buildings and above-ground tanks and placed a gravel and clay cap over most of the Site. Crushed stone was placed over three areas of surficial soil contamination along the northern border, southern border, and northeast corner. In 1986, EPA extended the Silresim perimeter fence to enclose an area of surficial contamination in the southeastern corner of the Site and placed crushed stone over surficial soil contamination.

After the site was added to the National Priorities List (NPL or the so-called "Superfund"), a Remedial Investigation and Feasibility Study were conducted, concluding that additional remedial actions were needed to address contamination in soil and ground water.

#### **4.2.3.2 Remedial Actions Specified in the Record of Decision**

In 1991, EPA issued a "Record of Decision (ROD)" detailing the cleanup activities that were to be conducted at the site. The ROD called for the following activities to be completed.

Management of Migration: The Management of Migration portion of the ROD remedy describes the implementation of a pump and treat system and includes the following major components.

1. Implementation of public education programs and institutional restrictions on future water use.
2. Installation of ground water extraction wells in both overburden and bedrock aquifers and construction of a ground water treatment plant (GWTP). The ground water treatment system described in the ROD includes the removal of both inorganic and organic ground water contaminants by gravity separation, metals pretreatment, air stripping, vapor phase thermal oxidation and liquid phase carbon adsorption. Following on-site treatment, the treated water would be discharged to the City of Lowell's sanitary sewer system. The ROD anticipated a cleanup timeframe for ground water of at least 30 years.
3. Operation and maintenance of the GWTP and long-term monitoring of ground water.



fig. 5 removal of drums

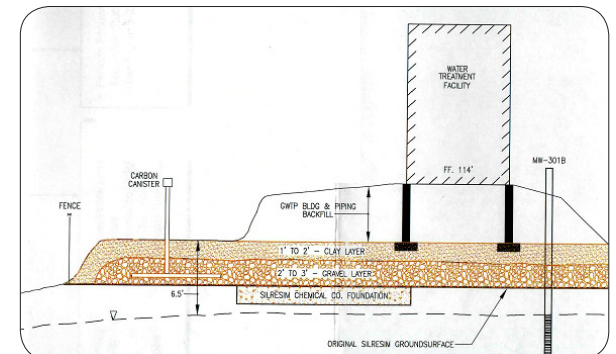


fig. 6 conceptual section of gravel and clay cap



fig. 7 installed gravel and clay cap at the silresim site

4. Disposal of non-aqueous phase contaminants and secondary wastes generated during the operation of GWTP.
5. Add water use restriction clauses to property deeds in areas of known ground water contamination.

Source Control: The Source Control portion of the ROD remedy involves treating surficial and unsaturated zone soils using soil vapor extraction (SVE) for removal of VOCs, followed by excavation and stabilization of soils contaminated with non-VOCs and inorganic compounds, followed by containment of treated soils under a RCRA Subtitle C cap.

The ROD specified that SVE was to be used to remove VOCs from approximately 37,000 cubic yards (cy) of soils. The estimated times to achieve VOC cleanup levels for the soils at the Site were:

- approximately three years for the gravel fill on the Silresim Property;
- approximately five years for the cinder and fill material throughout the Site; and
- approximately 30 years for the natural sandy silts throughout the Site.

Following SVE to remove VOCs, approximately 18,000 cy of soil at the Site (on and off the Silresim Property), contaminated with non-VOCs and inorganic compounds would be excavated and stabilized using a mobile treatment plant based on results from a soil stabilization treatability study. Excavated areas outside of the Silresim Property would be backfilled with clean fill. All stabilized soil will be disposed under a cap conforming to RCRA Subtitle C standards (Figure 8).

The ROD estimated that all the components of the Source Control remedy would be implemented within seven years after remedial design, although approximately 30 years would be required to achieve cleanup levels in the natural soils at the Site. This assumed that cleanup levels for VOCs in soils to be excavated and stabilized are reached in approximately five years, that stabilization will be implemented within one-half year and that the cap would be constructed in approximately one and one-half years.

### **4.2.3.3 Remedial Actions Completed after Record of Decision**

Ground Water Extraction and Treatment: In accordance with the ROD, a ground water extraction system consisting of 25 extraction wells and a GWTP were completed in November 1995. The GWTP was designed to extract the contaminated ground water and provide treatment prior to discharge to the existing sanitary sewer.

The system originally consisted of 25 extraction wells, each separately piped to a groundwater treatment plant. The original 25 extraction wells were screened in different vertical zones as follows:

- 13 shallow aquifer
- 2 moderate overburden
- 9 deeper overburden
- 1 bedrock

Each well was designed to pump at approximately 1 gpm. Historically, average production from each shallow wells was approximately 0.3 gpm per well, while average production from moderate and deep wells was approximately 1.5 gpm per well.

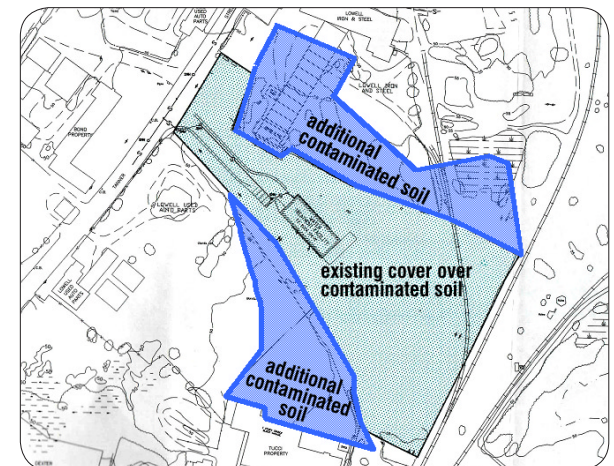


fig. 8 contaminated soil areas



Six new extraction wells were placed into service on February 2, 2001, and the overall pumping strategy was revised in an attempt to limit the downward migration of contaminants by focusing extraction in the shallow aquifer. There are six new wells (numbers 26-31), and these wells are operating with 11 of the original wells (numbers 2-8 and 11-13 & 17) for a total of 16 operating wells.

Currently, 11 of the wells are operating as shallow wells, with the exception of old Well 17 and new Well 31. Well 31 is located north of the property and is screened from above the first aquitard down to bedrock. The purpose of Well 31 is to intercept deep and shallow groundwater contamination that is already beyond the operating shallow extraction wells. EW-17 is intended to augment the capture zone for deeper groundwater, and is also located beyond the extent of the shallow wells. The new shallow wells are screened somewhat deeper than the older shallow wells, to increase the potential for greater water production.

The treatment plant was originally designed to handle 36,000 gallons per day (25 gallons per minute) of contaminated groundwater from the extraction wells. The original system consisted of the following:

- phase separation (currently by-passed)
- equalization tank
- metals removal
- multimedia filtration
- preheat of the air stripper liquid feed
- air stripping
- liquid granulated activated carbon polishing of the stripper
- effluent (recently eliminated)
- thermal oxidation of stripper off gases
- discharge of the treated aqueous stream to the City of Lowell POTW

The phase separator has never recovered product and has been by-passed, and the liquid phase carbon polishing step was eliminated by increasing the operating temperature of the air stripper. With the modifications to groundwater extraction, the plant currently is operating at about 10 gpm. The plant has recently been upgraded to 35 gpm capacity, which required upgrading to 2-inch piping, although there is no plan to operate the plant in excess of current rates (approximately 10 gpm) at this time.

The new extraction well operational pumping strategy is continuously being evaluated to confirm it is providing adequate capture of the groundwater plume. This evaluation will continue throughout the entire operations period of the GWTF to identify any necessary adjustments to the operational pumping strategy.

Since it was concluded that conventional or enhanced SVE would not likely attain the cleanup levels established in the ROD, a new approach was established for completing this phase of the Source Control Remedy. The EPA, the Massachusetts Department of Environmental Protection (MADEP), and the USACE developed an alternate plan for the application of SVE at the Site with the objective of maximizing the removal of volatile contaminant mass instead of attempting to achieve ROD cleanup levels.



fig. 8 water treatment plant on the silresim site



fig. 9 system inside of the treatment plant

#### **4.2.3.4 Anticipated Remedial Actions**

EPA is in the process of reevaluating the remedial options for the site, so a detailed discussion of future remedial actions is not possible. Thus, the following summary is speculative, based on discussions with EPA and their contractors.

**Capping:** EPA has indicated that they intend to construct a RCRA-C landfill cap on a portion of the site. Construction of this cap will likely raise the elevation of the capped portion of the site and will result in a vegetated surface profile.

EPA also recently conducted a supplemental soil testing program on areas that are directly adjacent to the Silresim Site. The results indicated elevated levels of soil contamination that may or may not be related to releases from the Silresim Site. EPA has indicated that they may extend the existing cover using soil or clay to prevent direct exposure.

**Soil Excavation:** Due to the elevated contaminant levels detected by EPA in the recent sampling exercise, EPA has indicated the possibility that some of the contaminated soils may need to be excavated and consolidated under the existing on-site cap, or disposed off-site.

**Ground Water Treatment:** Clearly the ongoing ground water treatment system will continue to operate for a minimum of several years. Continued operation of this system could involve installation of new wells, abandonment of old wells, addition of new above or below ground piping and additions or modifications to the ground water treatment plant.

**Six Phase Heating:** EPA is performing a pilot test of this innovative technology to remove VOCs from the subsurface in soil and ground water (Figure 10). If successful, the implementation would involve vertical advancement of long linear electrodes into the ground, followed by operation for several weeks (or even months). After treatment of one area, the electrodes would be removed and the whole process repeated in an adjacent contaminated area. Implementation also involves heating of the subsurface to high temperatures using electricity.

#### **4.2.4 Potential Development Restrictions**

Based on the anticipated remedial activities that may occur at the site, there are several potential restrictions that were considered in developing this reuse plan.

**GWTP Operations:** Site reuse must consider that the ground water treatment plant is likely to be operating in the present location for several years. The ROD for the site anticipated over 30 years of ground water treatment.

**Well Monitoring/Sampling/Maintenance:** One of the requirements of the ROD as well as a practical requirement in this remedial strategy is long term monitoring of ground water monitoring wells in the area. This will require that the ground water monitoring wells be accessible for many years. Despite the current configuration of many of the wells as “stick-ups,” these wells could be reconstructed to place the well apparatus entirely below the ground to accommodate reuse of the site.

**New Wells:** Depending upon the future changes that might occur in the extent of the ground water plume, it is possible

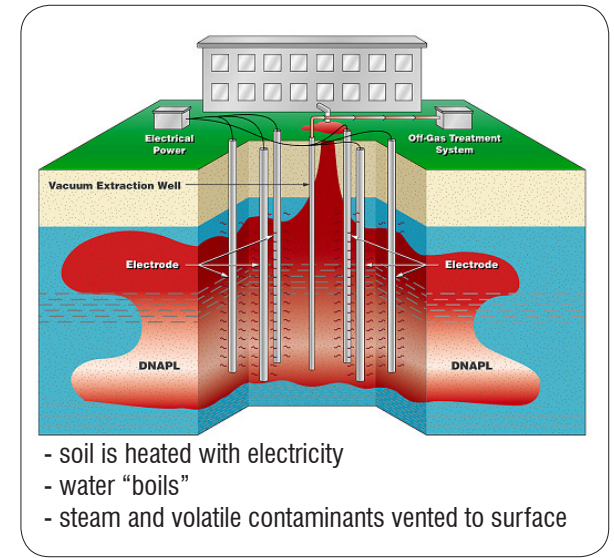


fig. 10 conceptual model of six phase radial heating of soil



that additional ground water extraction wells might need to be installed and added to the extraction system. Future reuse of the site would need to be flexible enough to accommodate this possibility.

**Piping:** Currently, there is an extensive network of piping that connects the ground water extraction wells to the ground water treatment plant. Some of this piping is buried, some is above ground, but in any case, future reuse of the site must accommodate the existing piping, as well possible new piping.

**Cap Upgrade/Construction/Maintenance:** There is an existing clay cap on the site and EPA anticipates installation of an additional cap on the site that could consist of multiple layers. For either cap, access for periodic inspection and maintenance is needed.

**Soil Excavation:** EPA is considering excavation of some surface soils from properties adjacent to the Silresim property and consolidation of these soils under an on-site cap. This would require that the affected areas be accessible in the future.

**Soil Treatment:** EPA is considering six-phase radial heating as a technology to treat soils as well as ground water at the site in the future. This technology uses electrical power, and some temporary surface equipment, as well as subsurface installations of electrodes. In addition, site security would be required to restrict access by untrained personnel. Obviously, this technology would also require accessibility for the equipment in the future.

**Indoor Air Quality:** Previous site testing at Lowell Iron and Steel indicated an indoor air quality problem. Any new on-site buildings should be designed to mitigate potential indoor air issues.

**Storm Water Management:** Given that one of the remedial objectives at the site is to minimize infiltration of rainwater through the contaminant mass, control of storm water drainage off of the cap will need to be continued at the site indefinitely.

### **4.2.5 Potential Reuse Design Considerations**

Given the limitations posed on site reuse by contamination that exists at the site, the ongoing remedial activities and the anticipated remedial activities at the site, there are several design considerations that should be incorporated into site reuse plans.

- Any structures planned for the site in the near-term should be designed as temporary or mobile with short-lifespan usage anticipated (such as parking areas, pre-fabricated buildings, etc.).
- Future reuse plans should be limited to small footprint designs (such as playgrounds, picnic areas, athletic courts, trails, ice rink, golf range, archery ranges, soccer, skate parks, etc.)
- Future reuses of the site must protect/armor site facilities (for example with landscaping, fencing, etc.)
- Separate access/entry for the reuse area should be designed to prevent access to the active portions of the site



fig. 11 extensive network of piping and wells



fig. 12 existing storm water drainage system

### **4.3.1 Best Management Practices(BMPs)**

#### ***Porous Paving***

Porous paving involves the use of load-bearing porous material in place of impervious asphalt. Porous pavement is typically installed in over-flow parking areas and as strips in more heavily used parking areas. Porous pavement allows for infiltration of rainfall and reduces the amount and impact of stormwater runoff.

#### ***Filter Strips***

Filter strips are bands of close-growing vegetation planted between pollutant source areas and a down-slope receiving waterbody. Filter strips can be used in combination with other Best Management Practices (BMPs) to achieve maximum retention of runoff.

#### ***Vegetated Swales***

Vegetated swales are depression areas that are planted with water-tolerant plant species. The two most common types of vegetated swales are: dry swales and wet swales. Dry swales provide both quantity (volume) and quality control by facilitating stormwater infiltration. Wet swales use residence time and plant growth to reduce peak discharge and provide water quality treatment before discharge to a down-slope location. Wet swales typically have water tolerant vegetation permanently growing in the retained body of water.

#### ***Vegetated Buffers***

Vegetated buffers are strips of vegetation that are planted around sensitive areas such as waterbodies, wetlands, and areas containing highly erodible soils. In addition to protecting sensitive areas, vegetated buffers help to reduce stormwater runoff impacts by trapping sediment and sediment-bound pollutants, providing some infiltration, and slowing and dispersing stormwater flows.

#### ***Vegetated Rooftops***

Vegetated rooftops are comprised of an impermeable layer covered with a nutrient-rich soil mixture and native vegetation. As the vegetation matures, it provides the following benefits: improvement of air quality, cooling of air temperatures, and retention and recycling of rainfall.

#### ***Wetland Terraces***

Wetland terraces provide a series of infiltration and cleansing processes as stormwater is conveyed through a multi-tiered terrace system. Water- and metal-tolerant plant species are used at varying degrees of intensity to filter pollutant-laden water as it is transported to the waterbody.



porous pavement used in a parking lot (typ.)



vegetated swale (typ.)



vegetated rooftop (typ.)

### 4.3.2 Phytoremediation Opportunities

Phytoremediation involves the use of plants to extract and/or stabilize toxic substances in contaminated soils. The establishment of vegetation on contaminated hazardous waste sites offers an attractive and economic alternative to many traditional soil removal and stabilization methods. Specially selected metal-accumulating plants are combined with innovative soil amendments to allow for the removal and/or stabilization of metals and other pollutants in soils. This process of extracting contaminants from the soil and accumulating them within the above- and below-ground plant tissue enables plants to be used as part of a soil clean-up technology.

Successful implementation of phytoremediation involves decreasing the concentrations of contaminants in the soil by means of plant uptake. Several conditions must be met for phytoremediation to be effective: first, the plants must be capable of extracting metals from soil; and second, the metals in the soil must be readily available for plant uptake. Metal availability is dependent on metal solubility, which is strongly influenced by soil characteristics such as soil water acidity and complexation capabilities of the soil and substances.

Due to the presence of pollutants outside of the Silresim Superfund boundaries, there are several opportunities for implementing small-scale pilot and demonstration phytoremediation projects. In areas where these pollutants exist within the typical root zone, it is possible to combine soil enhancers with select metal-tolerant plant species to create a productive medium for cleansing the soil of certain contaminants. The goal is to maximize soil productivity, biomass production, and evapotranspiration to create a natural soil cleansing system.

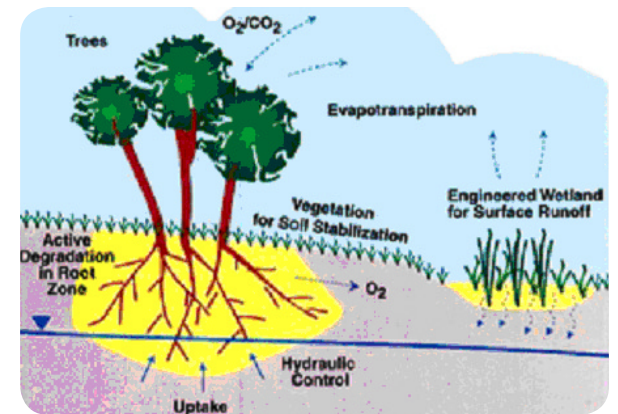


diagram of processes involved in phytoremediation



phytoremediation installations





<i>funding program</i>	<i>source</i>	<i>goal</i>	<i>potential projects</i>	<i>contact</i>
<b>federal funds</b>				
National Center for Environmental Research (NCER)	US EPA	Remediation through research	Remediation Forest Remediation Trail Bioremediation Terraces East Pond Park Park Eco-Tech	<a href="http://es.epa.gov/ncercq/rfa">http://es.epa.gov/ncercq/rfa</a>
Brownfields Economic Development Initiative, Assessment Demonstration Pilots/Grants	US EPA	to assess brownfields sites and to test cleanup and redevelopment models	Park Eco-Tech, Remediation Forest,	<a href="http://www.epa.gov/brownfields/pilot.htm#pilot">http://www.epa.gov/brownfields/pilot.htm#pilot</a>
Brownfields Economic Development Initiative, Brownfields Cleanup Revolving Loan Fund Pilots/Grants(BCRLF)	US EPA	to capitalize loan funds to make loans for the environmental cleanup of brownfields	Re-training Facility Green Tech Center Incubator redevelopment projects	<a href="http://www.epa.gov/brownfields/pilot.htm#pilot">http://www.epa.gov/brownfields/pilot.htm#pilot</a>
Small Business Innovative Research (SBIR)	US EPA	Remediation through research	Remediation Forest Remediation Trail Bioremediation Terraces East Pond Park Park Eco-Tech	<a href="http://www.epa.gov/ncercq/sbir">http://www.epa.gov/ncercq/sbir</a>
Brownfields Economic Development Initiative, Job Training Pilot Programs	US EPA	to provide training for residents of communities affected by brownfields to facilitate cleanup of brownfields sites and prepare trainees for future employment in the environmental field;	Re-training Facility	<a href="http://www.epa.gov/brownfields/pilot.htm#pilot">http://www.epa.gov/brownfields/pilot.htm#pilot</a>
Superfund Redevelopment Initiative (SRI) Assessment Demonstration Job Training Cleanup Revolving Loan Fund	US EPA	to help local governments participate in the cleanup and reuse of Superfund sites to ensure that site reuse is fully explored.	Re-training Facility Green Tech Center Incubator redevelopment projects Park Eco-Tech	<a href="http://www.epa.gov/superfund/programs/recycle/index.htm">http://www.epa.gov/superfund/programs/recycle/index.htm</a>
Supplemental Assistance for Assessment Pilots and Greenspace	US EPA	to empower States, communities, tribes, and other stakeholders in economic redevelopment to work together in a timely manner to prevent, assess, and safely cleanup brownfields to promote their sustainable reuse		<a href="http://www.epa.gov/swerosps/bf/html-doc/supguide.htm">http://www.epa.gov/swerosps/bf/html-doc/supguide.htm</a>
Clean Water State Revolving Loan Fund (CWSRF)	US EPA	to fund water quality protection projects for wastewater treatment, nonpoint source pollution control, and watershed and estuary management	East Pond Park Bioremediation Terraces	<a href="http://www.epa.gov/owm/cwfinance/cwsrf/index.htm">http://www.epa.gov/owm/cwfinance/cwsrf/index.htm</a>
Community Development Block Grant (CDBG)	US Dept. of Housing and Urban Development, Office of Community Planning and Development	to support individuals and community of low- and moderate-income, combat urban blight	Re-training Facility Hedgerow Screening Park Eco-Tech Remediation Forest	<a href="http://www.hud.gov/offices/cpd/communitydevelopment/programs/cdbg.cfm">http://www.hud.gov/offices/cpd/communitydevelopment/programs/cdbg.cfm</a>
Brownfields Economic Development Initiative Fund (BEDF)	US Dept. of Housing and Urban Development, Office of Community Planning and Development	to help redevelopment of abandoned, idled and underused industrial and commercial facilities	Re-training Facility Green Tech Center Incubator redevelopment projects	<a href="http://www.hud.gov/offices/cpd/economicdevelopment/programs/bedi/index.cfm">http://www.hud.gov/offices/cpd/economicdevelopment/programs/bedi/index.cfm</a>
Public Works Program	US Dept. of Commerce, Economic Development Administration	revitalize, expand, and upgrade of infrastructure to promote economic growth	Industrial access road water /sewer facility East Pond Park	<a href="http://www.osec.doc.gov/eda/">http://www.osec.doc.gov/eda/</a>

Economic Adjustment Program	US Dept. of Commerce, Economic Development Administration	support economic recovery from specific industry, strategic planning, project implementation, revolving loan.	Comprehensive Economic Development Strategy(CEDS) Re-training Facility Incubator redevelopment projects	<a href="http://www.osec.doc.gov/eda/">http://www.osec.doc.gov/eda/</a>
Community-Based Restoration Programs	US Dept. of Commerce, NOAA	to support local efforts to restore wetland, estuarine and riparian habitat	East Pond Park Bioremediation Terraces	<a href="http://www.nmfs.noaa.gov/habitat/restoration/community/about.htm">http://www.nmfs.noaa.gov/habitat/restoration/community/about.htm</a>
Strategic Environmental Research and Development Program (SERDP)	US Dept. of Defense	Remediation through research	Remediation Forest Remediation Trail Bioremediation Terraces East Pond Park Park Eco-Tech	<a href="http://www.sedrp.org/funding/nonfed/default.html">http://www.sedrp.org/funding/nonfed/default.html</a>
Empowerment Zone/Enterprise Community (EZ/EC) program	US Dept. of Housing and Urban Development			<a href="http://www.ezec.gov/">http://www.ezec.gov/</a>
Recreational Trails	US Dept. of Transportation and Federal Highway Administrations	to develop and maintain recreational trails for motorized and nonmotorized recreational trail users	Bioremediation Terraces	<a href="http://www.fhwa.dot.gov/tea21/factsheets/rec-trl.htm">http://www.fhwa.dot.gov/tea21/factsheets/rec-trl.htm</a>
Livable Communities program	US Dept. of Transportation	to strengthen the linkage between transportation services and the communities served	Remediation Trail	<a href="http://www.fta.dot.gov/IIIIIIresearch/polplan/susdev/livcom/livcom.htm">http://www.fta.dot.gov/IIIIIIresearch/polplan/susdev/livcom/livcom.htm</a>
Technical Assistance for Planning, assessment, and conservation in urban areas	US Dept. of the Interior	to enhance brownfields sites with open space and parks	Remediation Trail East Pond Park Park Eco-Tech	<a href="http://www.ncrc.nps.gov/programs/rtca/">http://www.ncrc.nps.gov/programs/rtca/</a>
Rivers, Trails and Conservation Assistance Program	US Dept. of the Interior, National Park Services	to help community to conserve rivers, preserve open space, and develop trails and greenways.	Remediation Trail, Environmental Clean-Up Days Art Festivals, other events	<a href="http://www.ncrc.nps.gov/programs/rtca/">http://www.ncrc.nps.gov/programs/rtca/</a>
"Brownfields to Brightfields"	US Dept. of Energy		Park Eco-Tech, Solar Farm	
Employment and Training (ETA)	US Dept. of Labor		Re-training facility	<a href="http://www.dol.gov/oasam/grants/prgms.htm">http://www.dol.gov/oasam/grants/prgms.htm</a>
Technical Assistance to brownfields Showcase Communities	US Dept. of Agriculture	to assist on projects on lands set aside for urban forestry, open space development and tree planting	Remediation Forest Remediation Trail Bioremediation Terraces East Pond Park Park Eco-Tech	<a href="http://www.epa.gov/swerosps/bf/html-doc/intragwg.htm">http://www.epa.gov/swerosps/bf/html-doc/intragwg.htm</a>
"Inner City" Urban and Community Forestry Grants	US Dept. of Agriculture, Forest Service	to create, protect, and manage community trees and forest ecosystems	Hedgerow Screening Park Eco-Tech Remediation Forest	<a href="http://www.na.fs.fed.us">http://www.na.fs.fed.us</a>
Wildlif Habitat Incentive Program (WHIP)	US Dept. of Agriculture, Natural Resource Conservation Service	to provide cost sharing options to develop and improve wildlife habitat primarily on private land	Hedgerow Screening East Pond Park Remediation Forest	<a href="http://www.nrcs.usda.gov/programs/whip/">http://www.nrcs.usda.gov/programs/whip/</a>

<i>funding program</i>	<i>source</i>	<i>goal</i>	<i>potential projects</i>	<i>contact</i>
<b>state funds</b>				
Urban and Community Forestry Program	Massachusetts Department of Environmental Management	to create, protect, and manage community trees and forest ecosystems	Hedgerow Screening East Pond Park Bioremediation Terraces	<a href="http://www.state.ma.us/dem/programs/forestry/urban/#urban">http://www.state.ma.us/dem/programs/forestry/urban/#urban</a>
<b>other funds</b>				
Small Business Innovative Research (SBIR)/Small Business Technology Transfer (STTR)	NATIONAL SCIENCE FOUNDATION	Remediation through research	Remediation Forest Remediation Trail Remediation Terraces East Pond Park	<a href="http://www.eng.nsf.gov/sbirspeccs/BT/bt.htm">http://www.eng.nsf.gov/sbirspeccs/BT/bt.htm</a>
Biocomplexity in the Environment (BE) for: Integrate Research and Education in Environmental Systems	NATIONAL SCIENCE FOUNDATION	Remediation through research	Remediation Forest Remediation Trail Remediation Terraces East Pond Park	<a href="http://www.nsf.gov">http://www.nsf.gov</a>
Green Building Programs	Massachusetts Technology Collaborative (MTC)	Alternative Energy	Park Eco-Tech, Solar Farm	<a href="http://www.mtpc.org">http://www.mtpc.org</a>
Green Power Programs	Massachusetts Technology Collaborative (MTC)	Alternative Energy	Park Eco-Tech, Solar Farm	<a href="http://www.mtpc.org">http://www.mtpc.org</a>
Water Management Program	MA DEP Division of Water Management (DWM)	Fish toxics monitoring survey		MA DEP DWM (508) 792-7470
Conservation Program	The Nature Conservancy	Land Purchase and Protection	Remediation Trail Remediation Terraces East Pond Park	The Nature Conservancy 4245 North Fairfax Drive, Suite 100 Arlington, VA 22203-1606 E-mail: <a href="mailto:comment@tnc.org">comment@tnc.org</a> (800) 628-6860
???	Sierra Club	Political activism, Media outlet (Sierra Magazine)		Sierra Club 85 Second Street, Second Floor San Francisco, CA 94105-3441 E-mail: <a href="mailto:information@sierraclub.org">information@sierraclub.org</a> <a href="mailto:sierra.magazine@sierraclub.org">sierra.magazine@sierraclub.org</a> (415) 977-5500
Green Cities Initiatives	Trust for Public Land	to create and restore urban parks	East Pond Park	<a href="http://www.tpl.org/">http://www.tpl.org/</a>
Enviro Action Grant Program	Patagonia, Inc.	Environmental Projects deal with root causes of problems and framework for long-term goals		Jil Zilligen or John Sterling: Patagonia, Inc. PO Box 150 Ventura CA, 93002 <a href="http://www.patagonia.com/enviro/main_enviro_action.shtml">http://www.patagonia.com/enviro/main_enviro_action.shtml</a>
Green Building Programs	Renewable Energy Trust	to design and install renewable energy solutions and alternative energy efficiency solution	Green Industry Incubator	<a href="http://www.masstech.org/massrenew/fundingopps.htm#gbi">www.masstech.org/massrenew/fundingopps.htm#gbi</a>







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